

## Ecology, ethology and control of green stink bug *Plautia affinis* dallas (hemiptera: pentatomidae) on mulberry *Morus alba* L. Varieties V-1 and M-5 from Kolhapur

T.V. Sathe<sup>1</sup>, B. V. Jadhav<sup>2</sup>, A.S. Desai<sup>3</sup>, Nilam Shendge<sup>4</sup>, Chandani Kamble<sup>5</sup> and A. D. Jadhav<sup>6</sup>

<sup>1, 3-6</sup> Department of Zoology, Shivaji University, Kolhapur-416004, India

<sup>2</sup> Department of Zoology, Balasaheb Desai College, Patan

E-mail: [profdrtsathe@rediffmail.com](mailto:profdrtsathe@rediffmail.com)

### ABSTRACT

Kolhapur is situated between 15<sup>0</sup> to 17<sup>0</sup> North latitude and 73<sup>0</sup> to 74<sup>0</sup> East longitude with an average rainfall 1100 mm mostly covered by monsoon and therefore with very rich biodiversity. Mulberry *Morus alba* L. V1 and M5 varieties have been attacked by the green stink bug *Plautia affinis* Dallas (Hemiptera: Pentatomidae) by sucking cell sap of leaves and other tender parts of the crop affecting nutritional quality of leaves of silk worm *Bombyx mori* L. The pest incidence was high during the months October- November and April- May on both varieties but, V1 was more susceptible than M5. Life cycle was completed within 34 days and 37.5 days on V1 and M5 varieties respectively. Both sexes were polygamous, mated mostly at day with pre-mating, copulation and post mating periods 4 days, 36 hr and 54 days respectively. In mating behavior receptive female displayed a chain of 8 steps. Oviposition showed a chain of behaviors viz., attraction of host, recognition antennal examination of host parts, up down movement of abdomen and actual oviposition. Barrel shaped eggs were laid on the undersurface of the mulberry leaves with clusters containing 7 to 19 eggs in each cluster. Preventive controls such as collection and destruction of egg clusters, nymphs and adults and clean cultivation found effective. Biocontrol agents *Trichogramma* sp., *Trissolcus* sp., *Gryan* sp. and *Alophora* sp. were also found effective in suppressing about 60% population of pest. 0.2% DDVP or 0.01% Parathion were found suitable for control of *P. affinis* with safe periods 17 and 13 days respectively.

**Key words:-** Green stink bug *Plautia affinis*, ecology, ethology, control, mulberry varieties

### INTRODUCTION

**M**ulberry Silk (*Bombyx mori* L.) industry is totally based on mulberry plants *Morus alba* L. There are 2 species of the Genus *Morus* and thousands of varieties reported from India (Sathe, 1998). The varieties like V1 and M5 are susceptible to attack of green stink bug *Plautia affinis* Dallas (Hemiptera: Pentatomidae) from Kolhapur region of Maharashtra. The adult bugs

are small, bright green with brown elytra. Both nymphs and adults suck the cell sap of mulberry and affect the nutritional quality and growth of the plant. There are 2 spp. of the genus *Plautia* namely, *P. fimbriata* and *P. viridocolis* found attacking vegetables and fruits trees in India (Azim, 2011). *P. affinis* is reared for the first time on mulberry from India. For ecofriendly and pesticide less control, information of green stink bug is essential on ecology, life cycle and ethology. Review of literature indicates that

stink bugs are studied with respected to ecology, life cycle and ethology by some workers. Noteworthy among them refer to Kirkaldy (1909), Kobayashi (1956), Atwal (1959), Singh & Sharma (1961), Mc Donald (1968, 1971), Bernon et al., (2004), Nielsen & Hamilton (2009), Mc Pherson & Mc Pherson (2000), Mizell (2008), Nathalie et al., (2013), etc.

## MATERIALS AND METHODS

Mulberry (*M. alba*) gardens of V1 and M5 varieties planted in Kolhapur have been selected for the ecological, ethological and management studies of green stink bug *P. affinis*. Kolhapur is situated between 15° to 17° North latitude and 73° to 74° East longitude with an average rainfall 1100mm covered by mainly monsoon and therefore, with very rich biodiversity. Occurrence, life cycle, mating, oviposition and damage by *P. affinis* were studied by spot observations in mulberry gardens (V1 and M5 varieties) at 12hr interval during the years 2012-2013. Five points, one at centre and four to sides in trial plot with one plant tagged were selected for occurrence studies. For life cycle studies observations on eggs laid, incubation, number of instars and time required for their development has been taken into account. Adult longevity, mating and oviposition by *P. affinis* were studied by regular spot observations at weekly interval till the death of plant bug. The damage aspects of plants by the bug have been visualized on the leaves and other parts when bug inserted beak into plant and sucked the cell sap. Later, changes in the plant parts especially leaves, buds, fruits and stems have been taken into account frequently. In addition to field work, mating,

oviposition, life cycle and damage under laboratory experiments were also conducted by potting small twigs of mulberry varieties in glass cage 25x 25x25cm. Virgin pair, one male and one female of *P. affinis* was caged in above glass cage for observation of mating and later the oviposition cases have been noted. Behaviors in life cycle were also studied in the laboratory (27 ± 1°C, 75° to 80°C, 12 hr photoperiod) in same glass cage on potted plants of mulberry. In the laboratory observations were taken six hour interval.

## RESULTS

Results recorded in tables 1 to 5 and figures 1 to 5 indicated that the occurrence of *P. affinis* on V1 and M5 variety of mulberry was higher in number in the months October, November and April, May. It was moderate in August, September, March, June, July on V1 varieties while it was low in September and February end on both the varieties. In December and January the pest taken winter sleep in adult stage in debris of crop leaves and other parts. More or less same trend of occurrence of the bug was noted on M5 variety of mulberry however, the number of adults noted on the crop was low to moderate and never found high as in V1 variety. The life cycle of *P. affinis* was relatively completed faster, with an average time of 35 days on V1 variety while on M5 it has taken an average time of 40 days in fields indicating V1 variety was favorable to the plant bug than M5, under laboratory conditions (27±1°C, 75 - 80%, Rh & 12hr photoperiod) it was completed within 34 days and 37.5 days on V1 and M5 varieties respectively.

**Table- 1 Occurrence of *P. affinis* on mulberry *M. alba* in Kolhapur**

Mulberry varieties	August	September	October	November	December	January	February	March	April	May	June	July
V1	++ (14)	++ (15)	+++ (19)	+++ (18)	- (-)	- (-)	+ (9)	++ (15)	+++ (19)	+++ (17)	++ (16)	++ (16)
M5	++ (13)	+ (8)	++ (16)	++ (14)	- (-)	- (-)	+ (8)	++ (13)	++ (15)	++ (15)	++ (14)	++ (14)

(+ = Low, ++ = Moderate, +++=High).

**Table-2 Life of *P. affinis* on mulberry varieties in Kolhapur**

Sr. No.	Mulberry variety	Development duration (days)		
		Incubation (days)	Nymphal (days)	Total (days)
1.	V-1	6.00	28.00	34.00
2.	M-5	6.5	31.00	37.50

The barrel shaped eggs were laid in clusters of 7 to 19. There were five instars in the nymphal stage. Both nymphs and adults sucked the cell sap of the mulberry leaves and tender stems and affected the growth and leaf quality.

**Table -3 Nymphal duration of *P. affinis* on V-1 and M-5 variety**

Sr. No.	Nymph stage	Duration (days) on V-1 Variety	Duration (days) on M-5 variety
1.	I	3-4 (3.5)	3-4 (3.5)
2.	II	4-5 (4.5)	4-5 (4.5)
3.	III	5-7 (6.0)	5-7 (6.5)
4.	IV	6-7 (6.5)	7-8 (7.5)
5.	V	6-8 (7.5)	8-10 (9.0)
Total		24-31 (28.00)	27-34 (31.00)

The details of duration of incubation, instars and completion of life cycles from egg to adult are given in tables 2 and 3. In mating behavior, receptive female of *P. affinis* displayed following steps: recognition of pair, remains of stationary by female, antennation, wing spreading, abdomen movement/ clearing and genital spreading, male turn, female pull and copulation while, non-receptive females showed following chain of steps: male turn present, female no response, male multi display sequences, kicking by female, abdomen movement, abdomen depression and final rejection.

Both males and females were polygamous. Female mated 2-4 times and males 4-5 times. Larger sexes were liked by both sexes for mating. Mating occurred mostly at day but, can occur at night. The premating, mating and post mating durations, mating interruption by extra males and food preferences given by both the sexes are recorded in table 4. Oviposition represented following chain of behaviors: attraction of host, recognition, antennal examination of host plant, up and down movement of abdomen and actual oviposition on host. Female searched another place if suitable host plant surface was not found. Other details of oviposition behavior are given in table 5. Mated

female oviposited in clusters containing 7 to 19 eggs in each cluster.

**Table -4 Mating behavior in *P. affinis***

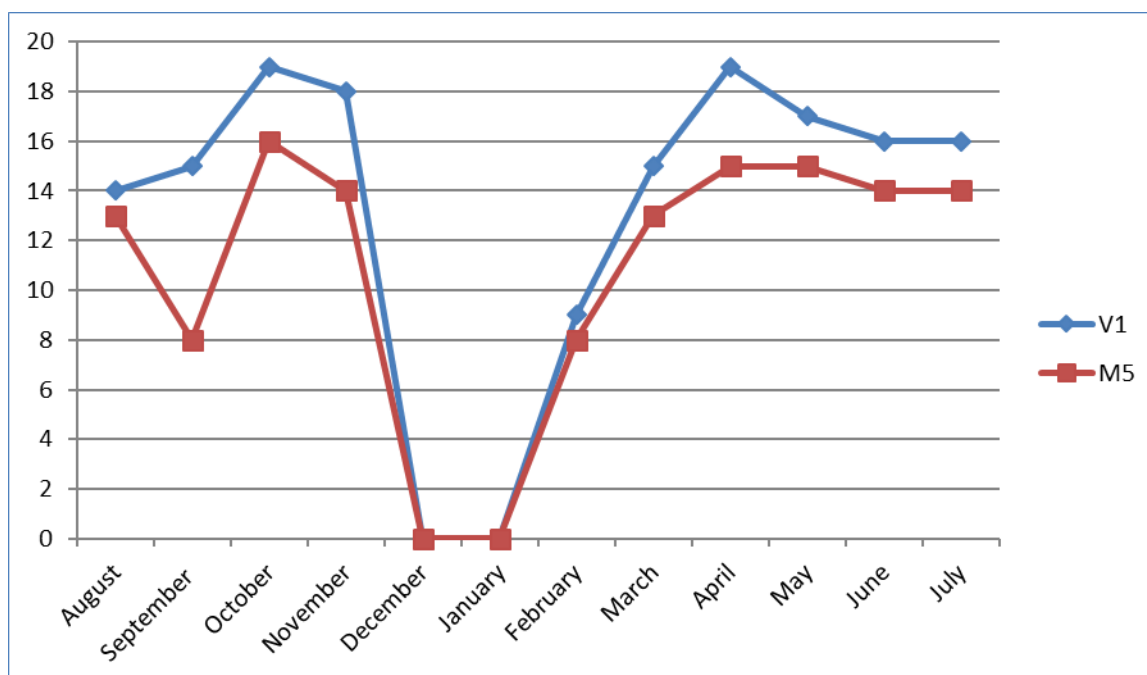
Sr. No.	Behaviour	Time
1.	Premating period	4 days
2.	Mating period- Copulation period	36.00 hours
3.	Post mating period	54 days
4.	Food preference	
	i) during premating	Yes
	ii) during mating	No
	iii) post mating	Yes
5.	Mating interrupted by other males	Yes, 20%
6.	Males	Polygamous (mate 4 to 5 times)
	Females	Polygamous (mate 2 to 4 times)

**Table-5 Oviposition behavior in *P. affinis***

Sr. No.	Behavior	Time
1.	Pre oviposition period	4.50 days
2.	Oviposition period	30min. - 1 hr
3.	Average number of eggs laid	12.50/female
4.	Post oviposition period	53 days
5.	Feeding after oviposition	Yes
6.	Feeding during oviposition	No
7.	Feeding before oviposition	Yes

#### **Nature of damage by *P. affinis* :**

Both nymphs and adults suck the cell sap of mulberry leaves and tender stem. As mulberry leaf buds were continuously sprouting, the bugs got ideal food. While sucking the cell sap from mulberry plant, the bug injected toxins into the

**Figure-1 . Occurrence of *P. affinis* on mulberry (V1 and M5) in Kolhapur**

plant body resulting leaves yellowing, withering and curly which ultimately affected the nutritive quality of the leaves, to be fed to the silkworms for better formation of cocoon. Poor the leaf nutritional content, inferior the cocoon quality. The stink bugs also secreted honey dew like substance over leaf surface of mulberry and caused sooty moulds which affected photosynthesis, growth of plant and leaf quality and quantity. The bugs were also responsible for transmission of vectors for certain viral diseases of mulberry such as mosaic, yellow net vein and ring spot. Due to viral diseases the leaves became curly inwardly, margins and tip showed chlorotic lesions; leaves got distorted and stained with yellow spots and finally the plant died.

*P. affinis* was found feeding on tomato *Lycopersicon esculantum* Mill, grape vines *Vitis vinifera* L., paddy *Oryza sativa* L. beans *Pisum sativum* L., red gram *Cajanus cajan* Mill and mustard *Brassica comprestis* L. in Kolhapur region.

### Control strategies for *P. affinis*:

#### Preventive control:

- 1) Collection and destruction of egg masses, nymphs and adults.
- 2) Clean cultivation of crop residues wherein the adult goes in diapause in winter.

### Biological control:

- i) Birds, toads and spiders eaten green stink bugs from mulberry garden. The Natural enemies should be encouraged in the garden by preparing resting sites and providing food.
- a) Various stages of plant bugs were attached by hymenopterous and dipterous parasitoids.
- b) *Trichogramma*- Egg parasitoid (10-18% mortality)
- c) *Trissolcus* sp. – Egg parasitoid (20-23% mortality)
- d) *Gryan* sp. (Scelenidae) ( 12-14% mortality)
- e) *Alophora* sp. (Tachinidae) adult parasitoid (10-15% mortality)

**Figure. 2. *P. affinis*: Mating, dorsal view**



**Figure-3. *P. affinis*: Mating, lateral view****Figure-4. Mulberry M5    Figure-5. Mulberry V1****Chemical control:**

Chemical control on mulberry ecosystems is not without danger since mulberry leaves are further used for feeding silk worms *B. mori*. Therefore, as possible use of pesticides be avoided. However, spraying the mulberry garden with either 0.2% DDVP or Parathion 0.01%, the pest population can be suppressed at large extent. Safe periods for above pesticides were 17 days and 13 days respectively.

Mc Donald (1971) found *P. affinis* on the flower *Salvia splendens* Ker-Gawl and as a minor pest on tomatoes and other vegetables. The duration life cycle from egg to adult was 37 days to 45 days. In the present study, the host was different, it was mulberry *M. alba*, V1 and M5 varieties and found completing its development

from egg to adult within 31 to 37 days on V1 and M5 varieties respectively and completed 3 generation on the mulberry in the Kolhapur region of Maharashtra where there is a very conducive environment for development of mulberry plantation. It seems that, mulberry was more favorable than *S. splendens*. Although it has been recorded on tomato *Lycopersicon esculantum* Mill. grape vines *Vitis vinifera* L., paddy *Oryza sativa* L., beans *Pisum sativum* L., red gram *Cajanus cajan* Mill. and mustard *Brassica campestris* L. in Kolhapur region.

Mc Donald (1971) reported 5 instars in *P. affinis*. The present findings are in agreement with this finding. His data given on the life cycle was based on observations made on insects kept in an insectory at  $26 \pm 2^{\circ}\text{C}$  and no humidity control. He reared the nymphs on *Salvia* plants and tomato fruits. In the present study, only V1 and M5 varieties have been tried, trials for other host plants would be interesting for counting its pest status on these crops in future.

In *Halyomorpha halys* Stal. (Pentatomidae) at Pennsylvania only one generation was possible during the single year (Bernon et al., 2008) however, Hoebeke and Carter (2003) recorded five generations completed by this brown marmorate stink bug. The adult mate in the spring approximately two weeks after emergence from the diapausing stage. More or less same situation was noted in the present form *P. affinis*. Maximum 400 eggs were laid by a single female of *H. halys* however, *P. affinis* laid maximum 51 eggs with 2 to 3 matings indicating its less reproductive potential than *H. halys*.

Mating is of interest for production of more males and less females for checking the pest population. However, in many cases mating favored the sex ratio towards the females. In *P. affinis* polygamous sexes led to increase females and thus risk of damage to crops. Some insects do not mate at day and some at night and vice versa (Sathe and Margaj, 2001) but, *P. affinis* but mated at day as well as at night. Receptive females of *P. affinis* displayed 10 distinct behaviors of mating. During the oviposition *P. affinis* displayed five steps viz, attraction of host,

recognition, antennal examination of host plants, up and down movements of abdomen and actual oviposition. Unsuitable host plant surface avoided by the plant bug.

Nathalie et al., (2013) developed an alternative method for pest management due to the increased concern for adverse effect of pesticides for human health and for the environment, for which they evaluated the adulticidal activity of the neotropical *Piper tuberculum* against *Dysdercus perivianus* G-M (Pyrrhocoridae). Therefore, emphasis should be given on biopesticides for insect pest management on mulberry ecosystem.

The use of pesticides on mulberry garden is not without danger to silkworms and humans due to contamination of mulberry leaves. Therefore, in present study, as preventive control, crop plant residues should be periodically removed for depriving the shelter of adult bugs wherein they go in diapause in winter season. Secondly, emphasis should be given on natural or biological control strategies of *P. affinis* since the pest is attacked by several birds, spiders and hymenopteran and dipteran parasitoids. The egg parasitoids like *Trichogramma* sp. and *Trissolcus* sp. which reduce the pest population at 35 to 41% at field conditions. Therefore, sheltering to birds and providing adult nutrition to parasitoids in the field condition can conserve biocontrol agents in better way and enhance the predatory and parasitism activity in field leading to higher mortalities in pest species as ecofriendly control.

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